

CLAIMS

1. A mould (2) for preparing of a wind turbine blade, a shell for a wind turbine blade or a large member intended to form part of a wind turbine blade comprising
  - 5 - a support structure (4),
  - an air-drainage system (6),
  - an active mould surface (12) and
  - an air-permeable surface member (8), through which air-permeable surface member (8), air may be transported between the active mould surface (12) and the
  - 10 air-drainage system (6),wherein the air-permeable surface member (8) forms substantially the entire active mould surface (12).
2. A mould (2) according to claim 1, wherein the air-drainage system (6) comprises a  
15 network for transport of air, preferably the network follows the active mould surface (12).
3. A mould (2) according to claim 1 or 2, wherein the air-drainage system (6) comprises islands (16) of solid material, the space between which is comprised by  
20 the network for transport of air, preferably the space between the islands (16) forms the two-dimensional network for transport of air.
4. A mould (2) according to claim 2, wherein at least one of the islands (16) has a cross section substantially resembling a geometrical shape, such as a circle, a  
25 triangle, a quadrangle or another polygon, preferably most or all of the islands (16) have a cross section substantially resembling a geometrical shape, such as a circle, a triangle, a quadrangle or another polygon.
5. A mould (2) according to any one of the claims 3 to 4, wherein at least two of the  
30 Islands (16) are connected by a connector (17) and the height of said connector is smaller than the height of the Islands (16).
6. A mould (2) according to any one of the claims 2 to 5, wherein the air-drainage  
35 system (6) comprises channels (10) for transport of air.

7. A mould (2) according to claim 6, wherein the cross section of most of the channels (10) for transport of air is greater than 1 mm<sup>2</sup>, preferably greater than 4 mm<sup>2</sup>, more preferably greater than 9 mm<sup>2</sup>.
- 5 8. A mould (2) according to claim 6 or 7, wherein the distance between at least some of the parallel neighbouring channels (10) for transport of air is between 0.4 cm to 20 cm, preferably between 0.5 cm to 5 cm, such as about 1 to 2 cm.
9. A mould (2) according to any one of the claims 6 to 8, wherein the distance  
10 between at least some of the crossings of channels (10) for transport of air is between 0.5 cm to 20 cm, preferably between 0.7 cm to 5 cm, such as about 1 to 2 cm.
10. A mould (2) according to any one of the claims 1 to 9, wherein the air-drainage  
15 system (6) is at least partially integrated in the support structure (4), preferably the air-drainage system (6) is fully integrated in the support structure (4).
11. A mould (2) according to any one of the claims 1 to 9, wherein the air-drainage  
system (6) is at least partially integrated in the air-permeable surface member (8),  
20 preferably the air-drainage system (6) is fully integrated in the air-permeable surface member (8).
12. A mould (2) according to any one of the claims 1 to 9, wherein the air-drainage  
system (6) is positioned between the support structure (4) and the air-permeable  
25 surface member (8), preferably as an independent member.
13. A mould (2) according to any one of the claims 1 to 12, wherein the air-drainage  
system (6) is intended to be airtight except towards the air-permeable surface  
member (8) and at least one opening to a pressure control system.
- 30 14. A mould (2) according to any one of the claims 1 to 13, wherein passage structures (14) provide air-permeability through the air-permeable surface member (8), and the passage structures have openings (18) towards the active mould surface (12), at least 90% of said openings covering an area corresponding to a circle with a  
35 diameter of less than 0,5 mm, preferably between about 10 µm to 250 µm, more preferably between 25 µm to 150 µm, such as between 50 µm to 125 µm.

15. A mould (2) according to claim 14, wherein the density of passage structure openings (18) towards the active mould surface is 1 to 1000 pr.  $\text{cm}^2$ , preferably the density is 2 to 200 pr.  $\text{cm}^2$ , more preferably the density is 5 to 100 pr.  $\text{cm}^2$ .
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16. A mould (2) according to any one of the claims 13 to 15, wherein at least 90% the passage structures (14) have an average cross-sectional area through the air-permeable surface member (8) corresponding to a diameter of less than 1 mm, preferably less than 0.5 mm, more preferably less than 0.25 mm, such as between
- 10 25  $\mu\text{m}$  to 150  $\mu\text{m}$ .
17. A mould (2) according to any one of the claims 13 to 16, wherein the air-permeable surface member (8) has an open volume comprising the passage structures (14) of less than 20 vol-%, more preferably an open volume of between 0.01 to 10 vol-%
- 15 and most preferably 1 to 4 vol-%, such as about 2 vol-%.
18. A mould (2) according to any one of the claims 13 to 17, wherein at least 90% of the passage structures (14) allow for straight transportation routes of air between the active mould surface (12) and the air-drainage system (6), such as via drilled
- 20 holes or bores.
19. A mould (2) according to any one of the claims 13 to 17, wherein at least 90% of the passage structures (14) allow for tortuous transportation routes of air between the active mould surface (12) and the air-drainage system (6), such as via pores in
- 25 a sintered or cured material or a foamed material.
20. A mould (2) according to any one of the claims 13 to 19, wherein the air-transportation distance (20) through the air-permeable layer (8) between the active mould surface (12) and the air-drainage system (6) is less than 5 mm, preferably
- 30 less than 3 mm, more preferably between 0.5 to 2.5 mm, such as between 0.75 to 2 mm.
21. A mould (2) according to any one the claims 1 to 20, wherein the air-permeable surface member (8) is sufficiently rigid to prevent substantial deformation of the air-permeable surface member (8) into the air-drainage system, preferably the
- 35 deformation of the air-permeable surface member orthogonal to the active mould

surface 12 is less than 2 mm, more preferably less than 1 mm and most preferably less than 0.5 mm.

22. A mould (2) according to any one of the claims 1 to 21, wherein at least a part of  
5 the air-permeable surface member (8) is heat resistant, preferably said part of the  
air-permeable surface member (8) is mechanically and chemically stable at the  
curing temperature of the item to be prepared in the mould, preferably at  
temperatures up to at least 80°C, more preferably at temperatures up to at least  
120°C and most preferably at temperatures up to at least 180°C.
- 10 23. A mould (2) according to any one of the claims 1 to 22, wherein the air-permeable  
surface member (8) comprises a sheet (22) of air-permeable material, preferably  
the air-permeable surface member (8) consists of said sheet (22), which is  
connected to the air-drainage system (6).
- 15 24. A mould (2) according to any one of the claims 1 to 23, wherein the air-permeable  
surface member comprises metal and/or plastic;  
the metal is selected from the group consisting of steel, aluminium and alloys  
comprising one or more of these;
- 20 the plastic is selected from the group consisting of thermosetting plastic,  
thermoresistant plastic, fibre-reinforced plastic, such as resin-deficient fibre-  
reinforced plastic, preferably comprising carbon fibres and/or glass fibres; the resin  
systems preferably comprising one or more systems based on epoxy,  
polyurethane, polyester and/or vinyl ester, such as epoxy novolac.
- 25 25. A mould (2) according to claim 24, wherein the air-permeable surface member (8)  
comprises a foamed material, such as a foamed thermosetting plastic or metal, or  
a cured, resin-deficient fibre-reinforced thermosetting plastic
- 30 26. A mould (2) according to any one of the claims 13 to 24, wherein passage  
structures (14) of the air-permeable surface member (8) were achieved by  
mechanical drilling, laser drilling, water drilling and/or electron beam perforation of  
a substantially dense material.
- 35 27. A mould (2) according to any one of the claims 1 to 26, wherein the air-permeable  
surface member is impregnated or coated with a mould-release agent, preferably

all the active mould surface is impregnated or coated with the mould-release agent.

28. A mould (2) according to any one of the claims 1 to 27, wherein the support  
5 structure (4) itself is a mould.

29. A mould (2) according to any one of the claims 1 to 28, wherein the air-permeable  
surface member (8) and/or the air-drainage system (6) is secured releasably to the  
air-drainage system (6) and the support structure (4), respectively.

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30. A subassembly for a mould according to any one of the claims 1 to 28, said  
subassembly comprising:  
- an air-drainage system (6) and  
- an air-permeable surface member (8) connected to said air-drainage system (6),  
15 through which air-permeable surface member (8) air may be transported between  
a surface of the air-permeable surface member (8) away from the air-drainage  
system (6) and the air-drainage system (6) when installed in a mould,  
and the air-drainage system (6) is adapted to be connected to a support structure  
(4).

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31. A subassembly according to claim 30, wherein the subassembly is capable of  
being plastically deformed to conform to a surface of a support, such as a support  
structure (4), preferably the subassembly comprises a curable material.

25 32. A method of manufacturing a mould according to any one of the claims 1 to 28,  
wherein the preparation of the air-drainage system (6) comprises the steps of:  
- introducing recesses, such as grooves, in the support structure (4),  
and/or  
- introducing recesses, such as grooves, in the air-permeable surface member (8),  
30 and/or the combination of the following steps  
- positioning a network for transport of air on a support, such as a support structure  
(4),  
- casting a curable tooling paste over the mesh  
- curing the tooling paste  
35 - removing the mesh.

33. A method of manufacturing a mould according to any one of the claims 1 to 28, wherein the preparation of the air-permeable surface member (8) comprises the steps of:
- sintering a powder, such as a metal powder, under conditions which provide a non-dense sintered material,
  - 5 and/or
  - at least partially curing a thermosetting resin with fibres, such as carbon fibres and/or glass fibres, under conditions where an inferior volume of thermosetting resin relative to fibres is used, hence forming a non-dense member,
  - 10 and/or
  - curing or sintering a foamed material, such as a thermoplastic and/or the combination of the following steps:
  - providing a substantially dense, solid material, such as a sheet of metal or thermosetting plastic, optionally reinforced by fibres,
  - 15 - perforating the material by drilling, such as mechanical drilling, water drilling, laser drilling, or by electron beam perforation.
34. A method of manufacturing a mould for preparing of a wind turbine blade or a shell for wind turbine blade, the method comprising the steps of:
- 20 - providing a support structure (4),
  - providing an air-permeable surface member (8),
  - providing an air-drainage system (6), said air-drainage system optionally being at least partially integrated in the support structure (4) and/or the air-permeable surface member (8),
  - 25 - optionally plastically deforming the air-permeable surface member (8) to conform to a surface of the support structure (4),
  - securing the air-permeable surface member (8) to the support structure (4), optionally via the air-drainage system (6), said securing preferably involves fasteners, adhesive and/or curing or co-curing one or more of the support structure
  - 30 (4), air-drainage system (6) and air-permeable surface member (8), more preferably, said securing involves adhesive.
35. A method of manufacturing a mould according to any one of the claims 1 to 28, comprising the steps of:
- 35 - providing a support structure (4),
  - providing a subassembly,

- optionally plastically deforming the subassembly to conform to a surface of the support structure (4),
- securing the subassembly to the support structure (4), preferably with fasteners, adhesive and/or by curing or co-curing the subassembly, more preferably with adhesive.

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36. Use of a mould according to any one of the claims 1 to 28 for preparing a wind turbine blade.

10 37. A method of manufacturing a wind turbine blade comprising the steps of:

- providing a mould (2) according to any one of the claims 1 to 28,
- optionally positioning and/or shaping a material to form a coating on the wind turbine blade in the mould (2),
- applying vacuum to the air-drainage system (6),
- 15 - placing fibres and/or resin in the mould (2) to form the wind turbine blade,
- optionally providing a vacuum enclosure between the mould (2) or the material to form the coating and the side of the wind turbine blade away from the mould (2),
- applying pressure and/or vacuum to the wind turbine blade,
- optionally introducing further resin into the blade,
- 20 - curing the wind turbine blade, and
- releasing the wind turbine blade from the mould, optionally facilitated by applying pressure via the air-drainage system.

25 38. A method according to claim 37, wherein a differential vacuum is created during at least a part of the processing, preferably the vacuum provided in the vacuum enclosure is at a higher absolute pressure than the vacuum provided on the surface on the item to be moulded via the air-drainage system (6), hence the vacuum force between the surface of the item to be moulded and the active mould surface is higher at any position than the corresponding vacuum force between the

30 vacuum enclosure and the item to be moulded.

39. A method according to any one of the claims 37 to 38, wherein the material to form the coating is a thermoplastic film suitable for a wind turbine blade surface with regard to weathering stability, preferably the material to form the coating comprises

35 an acrylic-based material, polycarbonate, PCDF, polyurethane or a blend

comprising one or more of these, more preferably the material is an acrylic material.

- 5      40. Use of a mould comprising a support structure (4), an air-drainage system (6), an active mould surface (12) and an air-permeable surface member (8), through which air-permeable surface member (8) air may be transported between the active mould surface (12) and the air-drainage system (6), wherein the air-permeable surface member (8) forms substantially the entire active mould surface (12), for preparing in-mould coated members.

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